Resin Casting for Rocketeers

Introduction

Nose cones, fins, transitions, and other model rocket parts can be easily produced using resin casting techniques. The time and effort that go into fabricating a custom nose cone or a built-up fin need only be expended once to produce a master pattern, around which an RTV (room-temperature-vulcanizing) rubber mold will be poured. The mold can then be used to cast many duplicates of the original part using two-part room-temperature-curing polyurethane resin.

This article is not intended to be a comprehensive guide, but rather a primer that will cover most of the unique molding and casting situations that model rocketeers will encounter. Although the RTV rubbers and resins are neither corrosive nor highly toxic, it is advisable to use them only in a well-ventilated area away from open flame or sparks. Before using the materials, read and understand the Material Safety Data Sheets and the manufacturer's safety instructions that are included with the RTV rubbers and resins.

Creating A Master Pattern

To produce an RTV rubber mold, a high-quality master pattern must first be made. A master can be made of any material that does not inhibit the curing of the RTV rubber. Balsa, cardboard, hardwood, plastic, metal, and sulfur-free "plasticene" modeling clay are suitable materials. Porous materials such as balsa must be sanded and sealed before the RTV can be poured over them. The master should also be clean and dry. RTV silicone rubbers and polyurethane resins will not cure properly if moisture is present on the master or mold.

To make a nose cone master, for example, a hardwood nose cone can be turned on a lathe or a drill press, then sanded and sealed. The nose should be sprayed with a wax-based release agent (Synair's Synlube 531, for example) and allowed to dry. The dowel at the nose's rear can be pressed into a smooth bed of sulfur-free "plasticene" modeling clay (other clays can inhibit curing in the RTV rubber). The dowel is pressed into the clay until the back of the tenon is flush with the clay surface. A superior master can be made by turning polycarbonate, lucite, lexan, nylon, or aluminum rod stock on a lathe. Masters made of these materials require neither sanding & sealing nor a release agent. A transition or a boat-tail would be produced in a similar fashion. Consult Peter Alway's "The Art of Scale Model Rocketry" (Saturn Press, 1994) for more information on turning parts.

Making The Mold Box

A mold box must be built around the master. It can be cardboard, wood, metal, or plastic. Porous box materials must first be sealed with a wax-based mold release or be covered with plastic tape like scotch tape. An easy way to make a small mold box is to roll a piece of sheet styrene into a cylinder, tape the seam, and stick it into the clay around the master. There should be 1/4" to 1/2" of space between the master and the walls of the mold box. The walls should be 1/4" to 1/2" higher than the master.

Mixing & Pouring The RTV Rubber

The RTV silicone rubber can now be mixed. RTV silicones consist of a rubber and a catalyst, and most are mixed in a 10:1 ratio (rubber to catalyst) by weight. For one-piece molds, use a low-durometer (soft) rubber no harder than a Shore A15 (Ace Resin's RTV and Dow Corning's HS-III RTV are A12). The rubber and catalyst are weighed (a postal scale is good for this) and mixed in plastic containers (do NOT use wax-lined or styrofoam cups). Pour the catalyst into the rubber and fold the rubber and catalyst together, being careful not to whip air into the mixture. Scrape the bottom and sides of the mixing container to make sure the rubber and catalyst are thoroughly mixed. It is often helpful to transfer the material into a second container to complete the mixing. Any unmixed material could leave uncured sticky spots in the mold cavity.

If you have access to a vacuum chamber, it is best to de-air the rubber before pouring it into the mold. De-airing prevents air bubbles from forming in the mold. If a bubble is on the surface of the master, every casting will have a raised "bump" at that spot. If you de-air the rubber, it should be in a container that is three to five times as high as the level of the rubber. The rubber will foam up to this height, then settle back down as the air bubbles escape.

If you don't have a vacuum chamber, pour the rubber slowly in a thin stream into the mold box. Pour it as far from the master as possible and let it rise up over the master of its own accord. This is advisable even if the rubber has been vacuum de-aired. The low durometer rubbers usually have low pouring viscosities, and some of them (Ace Resin RTV, Alumilite "Quick-Set" RTV, and Dow Corning HS-III & 3110) do not require vacuum de-airing. Some RTV rubbers, such as Alumilite "Quick-Set," will cure in as little as four hours, but for a long mold life it is best to let the rubber cure for at least twenty-four hours before attempting to use the mold. After the rubber has cured, carefully remove the clay from the master and then carefully remove the master from the mold.

RTV Rubber Versatility

The low-durometer RTV rubbers permit one-piece molds to be made to cast parts that would otherwise require multi-piece molds. For example, a "faceted" Nike fin with a through-the-wall mounting tab can be cast in a one-piece mold. The master pattern for the fin would be built-up using cardstock, sheet styrene, or waferglass bonded to an internal framework (see Peter Alway's "The Art of Scale Model Rocketry" (Saturn Press, 1994) for details). A cardstock master should be sprayed with a wax-based mold release. The mounting tab would be made longer than usual so that the excess length could be pressed into a smooth bed of plasticene modeling clay. A mold box would be built around the pattern and the RTV rubber would be mixed and poured. After the rubber cured, the clay would be removed from the mounting tab and the mold. To remove the master from the mold, the mold's bottom (which would be inverted to pour a casting) would be carefully slit with a modeling knife along a line passing down the fin root.

Casting A Part

An RTV silicone rubber mold is self-releasing and requires no release agent. However, mold life will be extended if a release agent is used. A silicone-based or wax-based release agent may be used. Another good release agent is talcum powder. It is especially useful in deep-draw molds such as nose cone molds. Drop a few pinches of powder into the mold, cover the opening, and shake it until the mold cavity is dusted with the powder.

The resin is very easy to measure and mix. Most polyurethane resins (Ace Resin, Alumilite, Por-A-Kast, etc.) are mixed 1:1 by volume. Equal volumes of the two parts are poured into separate containers. The "A" (or thinner) side can be poured into the "B" (or thicker) side and mixed, or both sides can be poured into a third container and mixed. Stir vigorously for 10-15 seconds or until a uniform color is achieved. Slowly pour the resin into the mold. The resin should cure

within 2-3 minutes. The curing resin will get quite hot (up to 215 degrees F for Alumilite), so let the casting cool to room temperature before attempting to remove it from the mold. The casting is still pliable while it is warm, so it could be distorted if it is removed from the mold before it cools to room temperature.

Fillers, Dyes, & Paints

The resins can be filled with any DRY filler (moisture reacts with the resins and produces carbon dioxide bubbles) up to 100% by volume. Aluminum powder can be added to give the cured part a metallic appearance, or microbulb filler (microballoons) can be added to lighten it so much that it would float on water. Several coloring dyes are available from Alumilite. The cured resins can be painted, stained, and plated.

Bonding Agents

The cured resins can be cemented to themselves and to kraft paper body tubes, balsa, cardstock, other plastics, and fiberglass with epoxy and cyanoacrylate adhesives. The resins can also be used as adhesives themselves. They adhere to metal, soft wood, and plastic.

Casting One-Piece Nose Cones

To cast a solid, one-piece resin nose cone (with tenon) in a one-piece mold, first fabricate a nose cone master as outlined above. Press it into plasticene modeling clay, build a mold box around it, then mix and pour the RTV rubber as described. Nose cones can be cast with a screw eye already installed. Slide the screw eye's eyelet onto a dowel or a rolled paper "stick." After pouring the liquid resin into the mold, hold the dowel or "stick" by the ends and insert the screw eye into what will become the back of the tenon, holding it steady until the casting solidifies. A simple jig can also be made to hold the dowel steady. A transition mold and casting would be made in the same way.

Molding A Two-Piece Hollow Nose Cone

Solid cast resin nose cones are fine for small models. At about 0.976" (BT-50) size, however, even a microballoon-filled resin nose cone may be too heavy to be practical. Using resin casting techniques, it is possible to make lightweight two-piece hollow nose cones.

Two masters are required for the nose cone (with tenon) and for the nose cone base--an outer shape and an inner "plug" for each piece. In the case of the nose cone, the outer shape would be turned on a lathe or a drill press. The plug would be turned in the same way, and it would have the same shape as the outer shape. The plug would not have a tenon, but rather a cylindrical section on the back that would have the same length as the outer shape's tenon. The plug's radius should be at least 3/32" less than the radius of the outer shape, and the plug's length would be proportionally less than that of the outer shape. The alignment pins (either turned with the piece or a dowel cemented into the blank before turning) on the plug and the outer shape will serve to center the two pieces in the next step.

Take the outer shape and press its alignment pin into a smooth bed of plasticene modeling clay. Press it in until the back of the tenon is flush with the clay's surface. Use a dowel or other object to make several depressions in the clay around the master, and build a mold box around these. The rubber will flow into these holes and create keys which will align the two mold halves. Mix and pour an RTV rubber as described above and set it aside to cure. After the rubber has cured, carefully remove the clay from the master and the mold, but leave the master in the mold. Next, either brush a rubber-to-rubber mold release ONLY on the exposed upper mold surface, or spray a wax-based mold release on the upper mold surface and the exposed part of the master. After it has dried, build a dam around the edges of the mold (sheet styrene taped around the edges is sufficient). Mix another batch of RTV and pour it onto the mold surface, then set it aside to cure. After the rubber has cured, separate the two halves of the mold. Remove the outer shape from the upper mold half.

Before casting a nose cone, insert the plug's alignment pin into the upper mold half and push it all the way in. Spray the plug with a wax-based release agent and allow it to dry. Mix the resin and pour it into the mold cavity, then slowly press the upper mold half into place. Allow the casting to cool to room temperature before removing it from the mold.

The plug must be sprayed with the release agent before casting each nose cone. If desired, a second all-RTV upper mold half can be cast. To do this, leave the hollow cast resin nose cone in the mold cavity. Spray the exposed upper mold surface with a wax-based release agent and let it dry. Build a dam around the mold edges as before. Mix a batch of RTV rubber and pour it onto the upper mold surface. Pour it away from the hollow nose cone and let the rubber slowly run down into the nose cone. After covering the upper mold surface (1/4" to 1/2" deep should be enough) with the rubber, set it aside to cure. The new upper mold half will have an integral plug. The nose cone base mold would be produced in the same way, and transition and boat-tail molds would use similar techniques.

"Pseudo Blow-Molded" Hollow Nose Cones

There is an easier way to make hollow nose cones. It requires only one master pattern. This method works best if the tenon has a truncated cone on its rear like blow-molded nose cones do, hence its name. Turn the master on a lathe or a drill press. It needs to have an alignment pin in the center of the tenon rear (the truncated cone). Press the master into a smooth bed of plasticene modeling clay, all the way up to the truncated cone/tenon interface. Use a dowel or other object to make depressions in the clay around the master, then build (or place) a mold box around these.

Because this casting method requires that the mold be held and rotated, it must be protected from being squeezed during casting. There are two ways to do this. The mold can be cast into a rigid cylinder (a length of plastic pipe, for example) or into a rigid box. Another method is to cast the mold in a temporary mold box, then brush on a thixotropic (a thixotrope is a gel that will not run when applied to a surface) mold support shell resin. Synair makes a mold support shell resin called Mother Mold, and other formulations are available from other casting suppliers. If you go this route, leave the master in the mold while brushing on the mold shell support resin. The mold itself will be a two-piece mold, and the piece covering the truncated cone will be the smaller of the two. Brush the mold shell support resin onto the entire mold except the top of the smaller piece. The cured mold support shell will be a rigid cylinder or box, open at the top so that the upper mold half can be removed.

Mix a batch of RTV rubber and pour it in a thin stream into the mold box. Pour it away from the master and let the rubber slowly rise up over the master. Set aside to cure. After the rubber has cured, carefully remove the clay from the master and the mold, but leave the master in the mold cavity. Brush a rubber-to-rubber mold release ONLY on the exposed upper mold surface, or spray a wax-based release agent on the upper mold surface and the exposed part of the master.

Build a dam around the upper edges of the mold (if you're not casting it in a rigid cylinder or a rigid box). Mix a batch of RTV rubber and pour it over the mold surface. Pour enough rubber that it rises almost to the top of the alignment pin on the truncated cone, then set it aside to cure. After the rubber has cured, separate the mold halves and carefully remove the master from the mold. The opening in the upper mold half left by the alignment pin is the channel into which the casting resin will be poured.

To cast a nose cone, assemble the mold halves and insert the mold into its cylinder, box, or shell. Cut a piece of pressure-sensitive adhesive paper (or a pressure-sensitive mailing label) large enough to cover the opening in the upper mold half. Cut or tear off a piece of masking tape. The tape will be used to keep the upper mold half from falling out of the box or shell during casting. Insert a funnel into the opening in the upper mold half. Mix the casting resin and pour it into the funnel, then quickly remove the funnel and press the pressure-sensitive adhesive paper over the opening. Using the masking tape, tape the upper mold half into place. Gently rotate the mold in all directions so that the resin coats the entire surface of the mold cavity. Rotate the mold until you can no longer hear the resin flowing inside, then set it aside to cure. The casting will be rather thin, so make sure it has cooled to room temperature before attempting to remove it from the mold. If desired, leave the casting in the mold and repeat the casting process to build up the casting's thickness. Hollow transitions and boat-tails can be cast in the same way.

Molding & Casting Materials Suppliers

Several suppliers of molding and casting materials are listed in Section 02 of the rec.models.rockets Frequently-Asked-Questions (FAQ) archive.

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